

A APPENDIX A: PM₁₀ GRASEBY/ANDERSON/GMW HI-
VOLUME SAMPLER

STATE OF IDAHO
DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR MONITORING QUALITY ASSURANCE

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

MONITORING, MODELING, AND EMISSIONS INVENTORY
APRIL 2001

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PM₁₀ GRASEBY/ANDERSON/GMW HI-VOLUME SAMPLER**Acronyms, Units, And Chemical Nomenclature**

AQS	Air Quality System
ASTM	American Society for Testing and Materials
EPA	Environmental Protection Agency
Hi-Vol	high volume
m ³ /min	cubic meters per minute
Mm	Millimeters (10 ⁻³ m)
mm Hg	Millimeters of mercury
µm	Micrometers (10 ⁻⁶ m)
µg/m ³	Micrograms per cubic meter
NAAQS	National Ambient Air Quality Standards
NIST	National Institute of Standards and Technology
NWS	National Weather Service
PM ₁₀	Particulate Matter with a Mean Aerodynamic Diameter of 10 µg or less
QA	Quality Assurance
SOP	Standard Operating Procedure
SSI	size selective inlet
VFC	Volumetric Flow Control

A.1 GENERAL INFORMATION

The reference method for high volume PM₁₀ (particulate matter with an aerodynamic diameter of 10 micrometers [μm] and less) sampling is found in 40 CFR Part 50, Appendix J. Sampler siting, operation, and quality assurance (QA) regulations are presented in 40 CFR Part 58, Appendix E. A good guideline for site selection is *Network Design and Optimum Site Exposure Criteria for Particulate Matter* (EPA-450/4-87-009). The sampler is essentially portable, requiring only a 115 volt, 10 amp AC outlet (the motor draws approximately 7 amps maximum). The operating procedures presented in this standard operating procedure (SOP) are derived from the cited regulations and the guidance presented in the manufacturer's instructions and the U.S. Environmental Protection Agency's (EPA) *Quality Assurance Handbook for Air Pollution Measurement Systems*, Section 2.12.

A.1.1 SPECIFICATIONS

STANDARDS:	State:	Federal standards adopted by Idaho
	Federal:	Primary and Secondary
		150 $\mu\text{g}/\text{m}^3$, 24 (± 1 hour) hour block average (midnight-midnight local standard time)
		50 $\mu\text{g}/\text{m}^3$ annual arithmetic mean
METHOD:		Graseby/Anderson/GMW High Volume Sampler Model G1200 size selective inlet
FLOW CONTROL TYPE:		Graseby/Anderson/GMW Sampler Volumetric Flow Control (VFC)
PROCEDURE:		High volume impaction
FILTER MEDIUM:		Quartz
RANGE:		2-500 $\mu\text{g}/\text{m}^3$; flow rate 1.13 actual m^3/min ($\pm 10\%$)
MANUFACTURER:		Graseby/Anderson/GMW

A.1.2 PRINCIPLES OF OPERATION

A high volume (Hi-Vol) PM₁₀ sampler (see Figure 23-1) consists of two basic components:

- 1) a specially designed size selective inlet (SSI) that, in theory, permits passage only of particles 10 micrometer (μm) and less in aerodynamic diameter, and
- 2) a flow control system capable of maintaining a constant volumetric flow rate within the design specifications of the inlet (1.13 actual cubic meters per minute [m^3/min]).

Two common types of flow control systems are available: the Mass Flow Control (MFC) and the Volumetric Flow Control (VFC) systems. This section discusses the VFC system used by the Department of Environmental Quality (DEQ).

The VFC Hi-Vol operates by pulling a determinable volume of ambient air at a constant volumetric flow rate through the SSI. Particle separation in the inlet occurs by inertial impaction. This is accomplished by forcing the air stream around a turn where the larger particles are forced by inertia from the sample stream and removed by impaction onto a greased shim. The smaller particles (10 μm and smaller) are

carried with the sample stream and collected on an 8 inch x 10 inch quartz filter that is weighed before and after sampling to determine the total mass collected. The “clean air” downstream of the filter is pulled through the VFC and motor and then exits through a plenum on the motor housing.

It is important to understand that the particles are not separated discreetly. That is, some particles larger than 10 μm in diameter are not removed from the air stream and reach the filter. However, particle separation is *most efficient* when the inlet is operating at the design flow rate of 1.13 actual m^3/min and when the inlet and impaction shim are clean. If the impaction shim is not kept clean, particle “bounce off” occurs and large particles are re-entrained into the air stream and removed by the filter. When this happens, the PM_{10} measurement is biased high. Because of this, it is important that an adequate maintenance schedule is employed to ensure that the Hi-Vol motor is in good operating condition and that the inlet is cleaned regularly.

The VFC on a Hi-Vol sampler is simply a tube called a choked venturi that connects the filter assembly to a downstream vacuum motor. Flow control is achieved by restricting, or occluding the airflow through a venturi. This causes the airflow to accelerate. Bernoulli’s law of physics states that the limiting velocity of air through the venturi is the acoustic velocity (speed of sound). Provided that the downstream vacuum is sufficiently large, the volume of air flowing through the venturi is a function of the internal diameter of the venturi, and the temperature of the air. The advantages of a VFC system are:

- 1) the volumetric flow is controlled without moving parts or electronic components,
- 2) the volumetric flow rate is unaffected by small changes in downstream conditions,
- 3) the volumetric flow rate is a predictable function of upstream air temperature, and
- 4) the flow rate stability is better than with other methods.

A.1.3 GENERAL HARDWARE

In addition to the two basic components of a VFC Hi-Vol PM_{10} sampler (the venturi and filter), ancillary components include:

- 1) the vacuum motor,
- 2) a six or seven day timer which allows the operator to set up the sampler several days ahead of the scheduled sample period,
- 3) a flow event recorder (sometimes referred to as a pressure transducer) that traces the flow on a circular chart and enables the operator to determine if the sampler ran steady and uninterrupted for the full sample period,
- 4) a filter cassette for holding the filter in place during sampling, and
- 5) an elapsed time indicator for measuring the total run time.

PM 10 High Volume Samplers

Approximate Weight: 60 lbs.

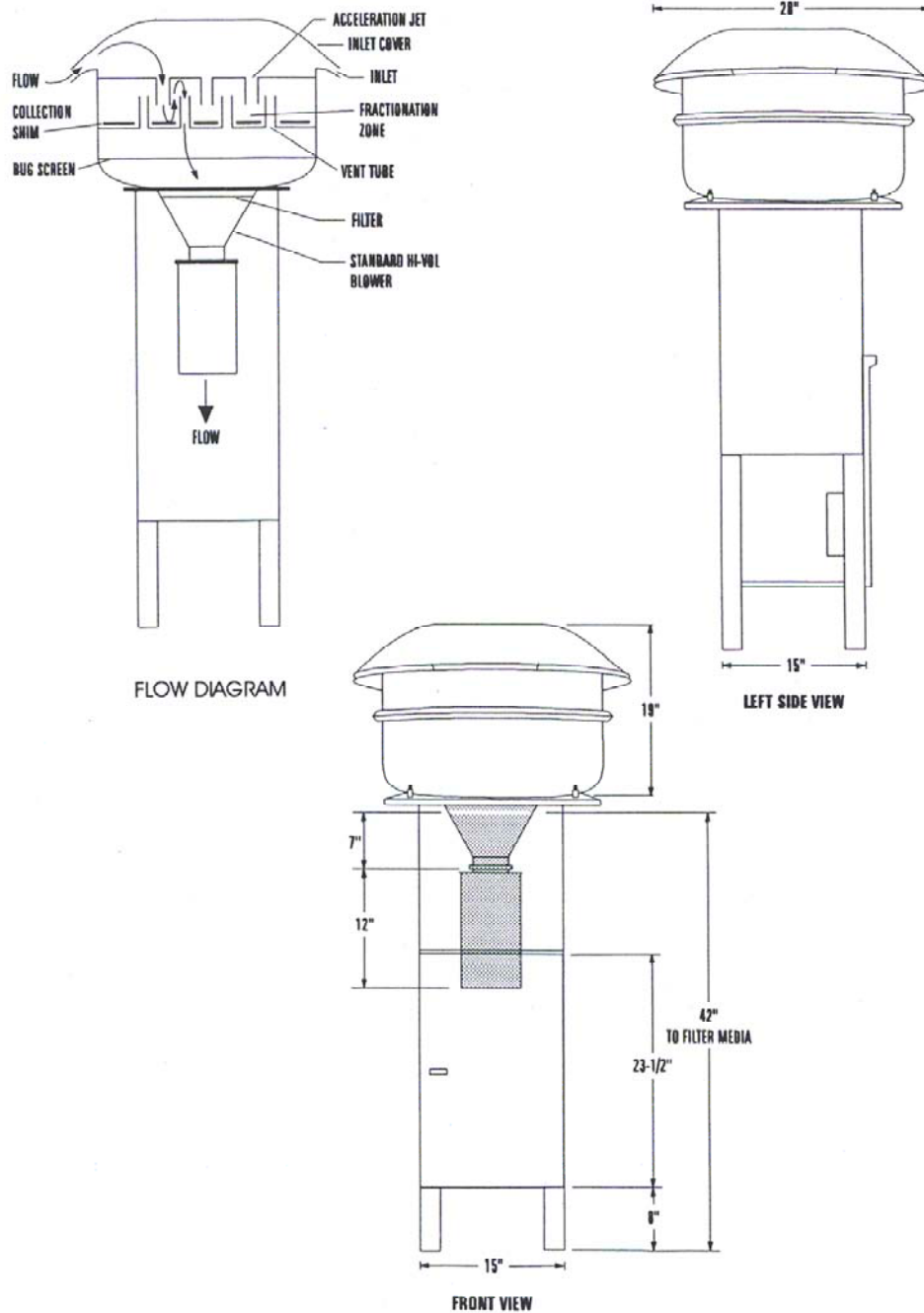


Figure 23-1. Graseby/Anderson/GMW High Volume PM₁₀ Sampler Diagram.

A.2 SAMPLE FREQUENCY

The PM₁₀ samplers are operated on a schedule determined by 40 CFR Part 58, Subpart B, Section 58.13. The National Ambient Air Quality Standards (NAAQS) revision published in the July 18, 1997, Federal Register requires a minimum sampling frequency of once every third day to coincide with the national particulate sampling schedule of once every sixth day. Less frequent sampling can be approved by the EPA Regional Administrator through a waiver request.

The sampling duration for each sampling period is 24 hours, midnight to midnight \pm 1 hour, local standard time, with sampler on and off times within 30 minutes of midnight. Any samples inadvertently taken on the incorrect sample day are still valid, but must be documented. Documentation should accompany the "Suspended Particulate Data Entry Form" (Figure 23-2) when it is submitted to the ambient air quality monitoring program at the DEQ State Office.

At those sites where the filter will be analyzed for other chemical constituents, the filters used must meet EPA's stated limits for trace elements. These limits may change annually so old filters or "off brands" may not be suitable for use at such sites. If any questions arise about EPA's current filter specifications, contact the DEQ State Office or EPA.

SUSPENDED PARTICLE DATA ENTRY FORM / STAG. PORT MANOMETER								
NAME	AIRS #	TYPE	MONTH	YEAR				
VFC								
SAMPLER #								
TO LAB								
FROM LAB								
RUN #	1	2	3	4	5	6	7	8
FILTER NUMBER								
Date								
Technician name								
RUN TIME								
TIME Load (min)								
TIME Unload (min)								
RUNTIME(min)								
STAG. PORT								
mmH2O Load								
mmH2O Unload								
PstgAve(mmHg)								
RUN DAY MET.								
Temp. (C)								
Temp. (K)								
P ave. (mb)								
P ave.(mm.Hg)								
C.F.								
Prat and CALIB.								
Pressure Ratio								
CALIB.Slope								
CALIB.Intcpt								
FLOWS (cu.m/min)								
Qstd								
Qact								
NET WEIGHT (mg)								
Particle								
RESULTS (µg/cu.m) STANDARD FLOW								
Particle (81102)								
RESULTS (µg/cu.m) ACTUAL FLOW								
Particle (85101)								

$$Q_{act} = [(Prat \cdot b)^{1/2} \cdot (Tav)^{1/2}] \cdot (1/m)$$

$$Q_{std} = Q_{act} \cdot CF$$

POLL	POC	INT	UNITS	METHOD	FREQ	START	DECIMAL
81102	1	7	001	063	6	0	0
85101	1	7	105	063	6	0	0

COMMENTS

RUN 1
 RUN 2
 RUN 3
 RUN 4
 RUN 5
 RUN 6
 RUN 7
 RUN 8

Figure 23-2. Suspended Particulate Data Entry Form.

A.3 SAMPLER CALIBRATION

A calibration is the numerical relationship between the sampler output (volumetric flow rate) and its flow indicator (stagnation pressure ratio). It is used to determine the volumetric flow rate for a given sample period. The stagnation pressure is an area of low pressure underneath the filter caused by the resistance to airflow through the filter. The stagnation pressure ratio is a mathematical relationship of the stagnation and ambient pressures. The equation used to calculate the stagnation pressure ratio is given below in the calibration procedures (Equation 4).

For the VFC Hi-Vol, there are two methods for determining sample volumetric flow rate:

- 1) using the manufacturer's look-up table, or
- 2) performing a multiple point (multi-point) calibration.

The manufacturer's look-up table is a matrix describing flow through the VFC at different pressures and temperatures. The volumetric flow rate can be determined from the look-up table by calculating the stagnation pressure ratio (described below) and then using the current temperature to read the corresponding volumetric flow rate from the matrix.

To ensure the accuracy of the manufacturer's look-up table, a three-point (minimum) calibration must be performed on a sampler during the sampler's initial setup. If the calibration curve agrees with the look-up table within $\pm 4\%$, then subsequent calibrations are not required unless a subsequent audit or flow check suggests an erroneous calibration, the sampler is moved to a different physical location, or major maintenance, such as VFC replacement, is performed.

Following the initial calibration, the operator can use either the look-up table or the multi-point calibration curve to determine sample period volumetric flow rates. Refer to the manufacturer's instructions on how to use a look-up table. A description of a multi-point calibration procedure follows.

A.3.1 MULTI-POINT CALIBRATION PROCEDURE

A.3.1.1 APPARATUS

- 1) National Institute of Standards and Technology (NIST) traceable variable resistance transfer standard (calibration orifice) with faceplate.
- 2) Portable thermometer, capable of accurately measuring temperature over the range of 0 to 50 °C to the nearest ± 1 °C and referenced to a NIST or American Society for Testing and Materials (ASTM) thermometer within ± 2 °C at least annually.
- 3) Portable barometer, capable of accurately measuring ambient barometric pressure over the range of 500 to 800 millimeters of mercury (mm Hg) to the nearest millimeter of mercury, and referenced within ± 5 mm Hg to a barometer of known accuracy at least annually.
- 4) 0-inch - 16-inch well type manometer with tubing.

- 5) 0-inch - 36-inch well type manometer with tubing.
- 6) Calibration Worksheet (Figure 23-3).

A.3.1.2 VARIABLES

In this section, the following variables are used or derived on the Calibration Worksheet.

- 1) $Q_a(\text{variable}) =$ Volumetric flow rate in actual m^3/min from the calibration curve or look-up table.
- 2) $\Delta H_2O =$ Pressure drop, in inches of water, across the calibration orifice.
- 3) $T_a =$ Ambient temperature, in Kelvin (K) ($K = ^\circ\text{C} + 273.15$).
- 4) $P_a =$ Ambient barometric pressure in mm Hg.
- 5) $\Delta P_{\text{stg}} =$ Relative stagnation port pressure.
- 6) $P_{\text{rat}} =$ Absolute stagnation pressure ratio.
- 7) $b =$ Intercept of the orifice transfer standard's calibration relationship.
- 8) $m =$ Slope of the orifice transfer standard's calibration relationship.

A.3.1.3 PROCEDURE

- 1) Open the SSI and, if applicable, remove the filter cassette. Securely install the faceplate adapter on the filter holder and the calibration orifice on the faceplate adapter. Open the calibration orifice for maximum flow.
- 2) Leak test the calibration orifice and sampler by placing your fingers over the four holes on top of the calibration orifice and one thumb over the manometer nipple on the orifice. Listen carefully for leaks, which are detectable as an audible whistling sound, and troubleshoot if one is heard.
- 3) Open each manometer's valve and zero the instrument. Connect a section of tubing from the calibration orifice nipple to one 16-inch manometer port. Connect a 36-inch well type manometer to the stagnation port fitting.

SITE LOCATION:

DATE: _____ CALIBRATED BY:

SAMPLER (VFC) NO.:

STANDARD PRESSURE: 760 mm Hg ACTUAL PRESSURE (P_a):

STANDARD TEMPERATURE: 298 K ACTUAL TEMPERATURE (T_a):

Transfer Standard slope (m):

Transfer Standard intercept (b):

Transfer Standard calibration date:

$$Q_a(\text{orifice}) = \frac{\sqrt{(\Delta H_2O) \left(\frac{T_a}{P_a} \right) - b}}{m}$$

$$X = \frac{Q_a(\text{orifice})}{\sqrt{T_a}}$$

$$Y = P_{rat} = \frac{P_a - \Delta P_{stg}}{P_a}$$

RUN	ΔH_2O in H_2O	STAG mm H_2O	PORT mm Hg	Q_a (orifice)	X-AXIS	Y-AXIS
1.						
2.						
3.						
4.						
5.						

Sampler Slope (m):
 Sampler Intercept (b):
 Correlation Coefficient (r):

Figure 23-3. High Volume VFC Calibration Worksheet.

- 4) Complete the top of the Calibration Worksheet including "Site Location," "Date," "Calibrated By," "Sampler (VFC) Number," "Transfer Standard Slope (m) and Intercept (b)," and "Date of Transfer Standard Certification."
- 5) Measure and record the ambient temperature (T_a) in Kelvin and the ambient barometric pressure (P_a) in millimeters of mercury.
- 6) Turn on and warm up the sampler until the manometer reading stabilizes.
 - a) Read the calibration orifice manometer (ΔH_2O) and record the number in the appropriate place on the Calibration Worksheet.

- b) Read the stagnation pressure port manometer (ΔP_{stg}) and record the number in the appropriate place on the Calibration Worksheet.
- 7) Slightly turn the calibration orifice clockwise to restrict the flow through the sampler. Repeat step 6 for at least two more volumetric flow rates. The range of the points should span the acceptable operating range of 1.017 to 1.243 actual m^3/min (± 10 percent of 1.130 m^3/min).
- 8) Return the sampler to operating order.
- 9) Calculate Q_a (orifice) for each data set:
- 10) Calculate "X" for each data set. Use the widest range of temperatures expected at the monitoring

$$Q_a(\text{orifice}) = \frac{\sqrt{(\Delta H_2O) \left(\frac{T_a}{P_a} \right) - b}}{m} \quad \text{Equation 1}$$

site.

$$X = \frac{Q_a(\text{orifice})}{\sqrt{T_a}} \quad \text{Equation 2}$$

- 11) Calculate P_{rat} or "Y" for each data set:

- a) Convert ΔP_{stg} to millimeters of mercury:

$$mm\ Hg = \frac{\Delta P_{stg} (in - H_2O) \times 25.4 \left(\frac{mm}{in} \right)}{13.61 \left(\frac{in - H_2O}{in - Hg} \right)} \quad \text{Equation 3}$$

- b) Calculate the absolute stagnation pressure ratio (P_{rat} , or "Y" axis):

$$Y = P_{rat} = \frac{P_a - \Delta P_{stg}}{P_a} \quad \text{Equation 4}$$

- 12) Using the data in the "X-Axis" and "Y-Axis" columns on the Calibration Worksheet, plot the calibration curve and calculate a least squares linear regression. This curve is used to determine the reported flow in actual cubic meters per minute for each sample run. Complete the Calibration Worksheet for the sampler slope (m), intercept (b), and correlation coefficient (r). A satisfactory calibration should have a minimum "r" value of 0.99.

- 13) Enter the slope and intercept into the Suspended Particulate Data Entry Form spreadsheet. This spreadsheet should be available at all Idaho DEQ Offices. The equation used by the spreadsheet to calculate sample flows for filters is:

$$Q_{act} = \frac{(P_{rat} - b) \times \sqrt{T_a}}{m} \quad \text{Equation 5}$$

A.3.2 SINGLE-POINT FLOW VERIFICATION CHECK

The single point flow check can be done after routine brush changes or motor changes or anytime a quality control flow check is needed. At a minimum, a single point flow verification must be done once quarterly. These can be done by the routine operator or by an independent or agency auditor. Throughout the year, any combination of flow check verifications (by the operator or by an auditor) will suffice as long as one flow rate verification is performed each calendar quarter.

This procedure compares a single measured volumetric flow rate against the volumetric flow rate from the calibration or the look-up table. The single point flow check is identical to a multi-point calibration except the single point flow check procedure measures only a single flow rate taken at or close to the design flow rate of 1.13 actual m³/min. This is done by installing a filter beneath the faceplate and fully opening the calibration orifice or (without the filter) by adjusting the calibration orifice so the sampler is drawing close to 1.13 actual m³/min. Refer to the instrument's operating manual for setup instructions. For the single point flow check, record the parameters listed below, as described in instrument's operating manual.

- 1) Ambient pressure and temperature (**P_a** and **T_a**)
- 2) Relative stagnation port pressure at a single point near 1.13 m³/min (**ΔP_{stg}**)
- 3) Pressure drop of calibration orifice at the same single point as in #2 above near 1.13 m³/min (**ΔH₂O**)

Following the measurement, calculate the calibration orifice flow rate (**Q_a[orifice]**) and compare it to the calibration or look-up table flow rate and to the design flow rate (1.13 m³/min):

- 1) Calculate **Q_a(orifice)** (Equation 1).
- 2) Find **Q_a** (sampler) using Equation 5 or the look-up table flow rate.
- 3) Calculate and record the percent difference between **Q_a** (indicated) and **Q_a** (orifice) using Equation 6:

$$\% \text{ difference} = \frac{Q_a(\text{sampler}) - Q_a(\text{orifice})}{Q_a(\text{orifice})} \times 100 \quad \text{Equation 6}$$

Where:

Q_a (sampler) = Indicated volumetric flow rate of the sampler from the calibration curve or the look-up table.

Q_a (orifice) = Actual volumetric flow rate through the calibration orifice.

- 4) If the percent difference is greater than 7%, recheck the calculations, check the sample train for leaks, and troubleshoot as necessary.
- 5) Calculate the design flow rate percent difference using Equation 7:

$$\% \text{ difference} = \frac{Q_a(\text{orifice}) - 1.13}{1.13} \times 100 \quad \text{Equation 7}$$

If the design flow rate percent difference is greater than 10%, recheck the calculations and check the sample train for leaks.

A.4 OPERATIONAL PROCEDURES

A.4.1 OFFICE PREPARATORY PROCEDURE FOR FILTER CHANGES

1. Remove a clean, unexposed filter from storage. The filters are fragile and should be handled with care. Each filter has been tare weighed, so it is important that the filters remain intact. Use forceps or wear silk, plastic, or latex gloves when handling the filters. If using forceps, be careful not to tear or puncture the filter, and do not touch the filter with the fingers. Inspect the filters closely and discard damaged filters.
2. Record the run date and filter number on the Stagnation Port Field Sheet (Figure 23-4)
3. Install a new filter on the designated cassette and center the unexposed filter with the *number-side down on the screen*. Attach the filter holder to the cassette screen and tighten the brass-knurled thumbnuds while ensuring the filter remains centered.
4. Record the run date, site name, filter number, and operator's initials on the back of the flow recorder chart and on the envelope.
5. Transport the filter and flow recorder chart to the sampling site.

STAGNATION PORT FIELD SHEET

SITE LES BOIS MONTH MARCH YEAR 2002

RUN DATE	FILTER NUMBER		TEMP (°C)	AMB. PRESS (MM HG)	PSTG. (MM H ₂ O)	HOBBS (MINS)	COMMENTS
3-3	Q1072570	ON	-0.6	696	450	387397	
		OFF	6.0	691	462	388838	
3-9	Q1072574	ON	6.0	691	462	388838	Brush Change
		OFF	7.0	687	467	390277	
3-15	Q1072576	ON	7.0	687	457	390277	Quarterly Audit (3/11)
		OFF	0.7	688	450	391721	
3-21	Q1072580	ON	0.7	688	455	391721	Quarterly Maint. (3/19)
		OFF	11.7	685	470	393160	
3-27	Q1072582	ON	11.7	685	457	393160	
		OFF	18.1	684	480	394598	

Figure 23-4. Stagnation Port Field Sheet.

A.4.2 FIELD PROCEDURE

- 1) Essential Equipment
 - a. 36-inch manometer
 - b. On-site or portable thermometer
 - c. On-site or portable barometer
- 2) Filter Setup for Initial Run
 - a. Unfasten the hold-down clips at the base of the SSI and tilt back the inlet until the supporting arm locks in place.
 - b. Remove the protective cover and install the prepared cassette. Secure the hold-down nuts firmly, but do not over-tighten.
 - c. Unlock the supporting arm, lower the SSI, and secure the inlet with the base clips.

- d. Insert the new flow recorder chart into the flow recorder. Center the tab on the slotted drive. Ensure that the chart will rotate 360° without binding or slipping.
- e. Read the elapsed time indicator and record on the Stagnation Port Field Sheet.
- f. Open the manometer's valves to the atmosphere and plug the manometer into the stagnation port on the right-hand side of the monitor. Zero the manometer fluid using the sliding scale. The manometer is usually read at the bottom of the meniscus.
- g. Start the sampler by tripping the timer switch to the "on" position. Allow the motor to warm up until the manometer reading is steady (approximately 3 to 5 minutes). Record the manometer reading in the "Pstg" column in the "On" row on the Stagnation Port Field Sheet.
- h. If an on-site pressure and/or temperature recorder is being used, reset or reinstall the chart paper as necessary (depending on type of recorder).

NOTE: For each sample period, use the 24-hour pressure and temperature values for the midnight-to-midnight sampling period. Ideally, temperature and pressure from a National Weather Service (NWS) site or local meteorological site should be used. Use the pressure at the station and *not* the pressure adjusted to sea level. When these data are not available, the pressure can be estimated based on elevation using Equation 8:

$$P_{est} (mmHg) = 753.56 - (elevation(ft) * 0.02425) \quad \text{Equation 8}$$

A single pressure estimate can be used since pressure fluctuation over time is insignificant. Temperature is more critical because of unpredictable fluctuations. If nearby temperature data is not available, it is recommended that an on-site temperature recorder be installed. Seven-day chart recorders are available.

- i. Turn the sampler off.
- j. Check the timer clock to ensure that the indicator arrow accurately points to the current standard time. It should not deviate from the current time by more than 30 minutes.
- k. By turning the dial clockwise, set the timer clock to start the sampler at the predetermined start time of 0000 hours (midnight) on the designated sample date, and to shut off at 2400 hours (midnight) (±30 minutes).
 - i) The on and off timer pins should represent a 24-hour 00 minute time period, midnight-to-midnight, local standard time. Once set, these pins should require no additional adjustments.
 - ii) When setting the timer to start the sampler on the run date, count (from the current calendar day) the calendar days counterclockwise from the indicator arrow on the timer face to the period indicated between the timer pins. If the timer is set properly, the period between the timer pins should be the run date.

- l. Close the shelter door and ensure the tubing for the flow recorder chart and the electrical cords are not pinched.
- m. If the manometer is permanently secured at the monitor site, disconnect the manometer from the monitor stagnation port and close the manometer valves to prevent dirt, water, and microbes from entering the manometer tube.

3) Filter Setup for Subsequent Runs

- a. When approaching the monitor, observe that the unit is reasonably undisturbed (e.g., from wind storms, vandalism, or other disturbances) since the last site visit. Report any abnormalities in the "Comments" section on the stagnation port field sheet.
- b. Start the sampler by tripping the timer switch to the "on" position. Allow the motor to warm up approximately 3 to 5 minutes.
- c. While the sampler is warming up, open the manometer valves and zero the manometer fluid using the sliding scale. Plug the manometer into the stagnation port on the right-hand side of the monitor. On the Stagnation Port Field Sheet, record the manometer fluid level in the "Pstg" column in the "Off" row.
- d. If an on-site pressure and/or temperature recorder is being used, reset or reinstall the chart paper as necessary (depending on type of recorder).

NOTE: For each sample period, use the 24-hour pressure and temperature values for the midnight-to-midnight sampling period. Ideally, temperature and pressure from a NWS site or local meteorological site should be used. Use the pressure at the station and *not* the pressure adjusted to sea level. When these data are not available, the pressure can be estimated based on elevation using Equation 8.

A single pressure estimate can be used since pressure fluctuation over time is insignificant.

Temperature is more critical because of unpredictable fluctuations. If nearby temperature data is not available, for example at a remote site, it is recommended that an on-site temperature recorder is installed. Seven-day chart recorders are available.

- e. Turn the timer switch to the "off" position. Record the elapsed time meter reading in the appropriate column on the Stagnation Port Field Sheet.
- f. Ensure the flow recorder is operating properly. Record the monitor location, run date, filter number, and operator's initials on a new chart. Remove the used flow recorder chart and insert the new chart. Be sure that the chart will be able to rotate the full 360° without binding or slipping.
 - i) Perform a quality control check of the used flow recorder chart by observing the chart trace for uniformity, consistency, and duration. Radial lines indicate power interruption or power failure.

- ii) Note any pertinent comments or anomalies on the Stagnation Port Field Sheet.
- g. Unfasten the hold-down clips at the base of the SSI and tilt back the inlet until the supporting arm locks in place.
- h. Observe the filter for any damage or unusual deposition.
- i. Loosen the hold-down nuts from the cassette. Cover the exposed filter with the cassette protective cover and remove the cassette. Store the filter cassette with the exposed filter in a protected area for transport to the office. The exposed filter should be handled and transported horizontally to minimize particulate loss.
- j. Install the previously prepared cassette.
- k. Unlock the supporting arm, lower the SSI, and fasten the base clips.
- l. Start the sampler by tripping the timer switch to the "on" position.
- m. Read the manometer fluid level and record it in the "P_{stg}" column in the "On" row on the Stagnation Port Field Sheet.
- n. Turn the timer switch to the "off" position.
- o. Check the timer to ascertain that the indicator arrow points to current local time of day. This should always reflect standard time, so the clock will actually be set one hour early during daylight savings time.
- p. By turning the dial clockwise, set the timer clock to start the sampler at the predetermined start time of 0000 hours (midnight) on the designated date, and to shut off at 2400 hours (midnight) (± 30 minutes).
 - i) Timer pins should represent a 24-hour time period, midnight-to-midnight. Once set, these pins should require no additional adjustments.
 - ii) When setting the timer to start the sampler on the run date (from the current calendar day), count the calendar days counterclockwise from the indicator arrow on the timer face to the period indicated between the timer pins. If the timer is set properly, the period between the timer pins should be the run date.
- q. Close the shelter door and ensure the flow recorder chart tubing and electrical cords are not pinched.
- r. Fill out the Stagnation Port Field Sheet completely and accurately each month. Include references to weather conditions and any unusual activities that might increase or decrease the normal fine particulate loading level (for example, building construction, excavation, forest fires, high winds, etc.).

A.5 PM₁₀ FILTER HANDLING AND REPORTING PROCEDURES

A.5.1 EXPOSED FILTER HANDLING

- 1) Remove the filter from the cassette. Wear plastic, silk, or latex gloves at all times when handling the filters.
- 2) Inspect the filter for damage, including tears and blurred or fuzzy borders. An acceptable filter must have a uniform sharp white border. Dark streaks into the border indicate a poor seal of the filter holder gasket.
- 3) Carefully remove insects and/or any obviously large debris from the filter.
- 4) Length-wise, fold the filter in half ***with the exposed side inward***.
- 5) Place the filter in a plastic envelope and insert it in a manila envelope. The location, operator's initials, and run date should already be recorded on the manila envelope (do this before leaving the office). Record any relevant comments on the envelope, such as, "VOIDED FILTER--MOTOR FAILURE." Be certain the exposed filter number corresponds to the matching number on the manila envelope.
- 6) Insert the appropriate flow recorder chart into the corresponding manila envelope.
- 7) Store envelopes containing exposed filters in a freezer until they are submitted to the laboratory.

A.5.2 EXPOSED FILTER DATA REPORTING

- 1) Submit exposed filters to the laboratory monthly. The filters must be mailed in a monthly batch no later than the fifteenth of the month following the month when they were collected. Group the filters by site, and fill out a Lab Particulate Data Report (Figure 23-5) for each site. Record the site name, the site Air Quality System number, the month and year of collection, the date the filters were sent to the laboratory, the filter numbers with the associated sampling date, and any necessary comments on the form.
- 2) Verify that the filter and flow recorder chart are in the appropriate numbered manila envelope, that the data on the envelope is the same as the data on the Stagnation Port Field Sheet (Figure 23-6), and that any comments are recorded on the envelope and the Lab Particulate Data Report.
- 3) Send the filters and the corresponding Lab Particulate Data Reports to:
Bureau of Laboratories
2220 Old Penitentiary Road
Boise, Idaho 83712
- 4) After the exposed filters have been final weighed, the laboratory will return the Lab Particulate Data Report with the net weight of the particulate. DEQ State Office personnel pick up the filters monthly for archiving and quality assurance/quality control purposes.
- 5) Upon receipt of the Lab Particulate Data Reports with the net weights, use the information recorded on the Stagnation Port Field Sheet and the Lab Particulate Data Report to enter the

required data into the Suspended Particulate Data Entry Form spreadsheet. The required information to be entered on a monthly basis is highlighted in the Suspended Particulate Data Entry Form spreadsheet. Other information, such as the calibration slope and intercept, only need to be re-entered when the conditions change. Password-protect the cells containing relatively stable data to prevent accidental changes. Upon entering the information into the spreadsheet, the spreadsheet will generate the final concentration at both standard and actual conditions for each sample.

- 6) Send hard copies of the worksheets listed below to the State Office within six weeks of the end of the relevant month for the final quality assurance check. The State Office will submit the data into the Air Quality System database within 90 days after the quarter in which the samples were collected.
 - Lab Particulate Data Report
 - Suspended Particulate Data Entry Form
 - Stagnation Port Field Sheet
 - Meteorology report (if applicable)
- 7) Following the laboratory's final mass analysis of the filters, check the final Lab Particulate Data Report to ensure it is complete and accurate.

LAB PARTICULATE DATA REPORT				
0		LAB # 84-85340E96-000-5009		
STATION NAME: Boise Mt View School SENT TO LAB: 0				
STATION # 160010011		RECEIVED BY LAB:		
MONTH July		REPORT BY LAB:		
YEAR 2002				
Filter Number	Date July	Net Weight (mg) Particulate	Lead	Comments
Q2003796	1			
Q2003798	7			
Q2003800	13			
Q20037802	19			
Q2003804	25			
Q2003806	31			
0	0			
0	0			
		LAB OPERATOR		

Figure 23-5. Lab Particulate Data Report.

SITE	MONTH	YEAR	AQS #	RUN DATE	FILTER NUMBER		TEMP. (°C)	AMB. PRESS. (mm Hg)	PSTG. (mm H ₂ O)	HOBBS (MINS)	COMMENTS & TECH INITIALS
						ON					
						OFF					
						ON					
						OFF					
						ON					
						OFF					
						ON					
						OFF					
						ON					
						OFF					
						ON					
						OFF					

Figure 23-6. Stagnation Port Field Sheet.

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A.6 PREVENTATIVE MAINTENANCE

Preventative maintenance is accomplished by properly following the normal operating procedures outlined in this section and in manufacturer's manual. All preventative maintenance activities should be recorded on the Stagnation Port Field Sheet, the Calibration Worksheet, or in the site logbook. Records should be kept on (but are not limited to) the following:

- 1) Leaks
- 2) Tubing replacement
- 3) Plug and wiring alterations
- 4) Clock accuracy checks
- 5) Flow recorder chart adjustment or replacements
- 6) Sampler housekeeping
- 7) Audit percent differences and dates
- 8) Calibration/recalibration
- 9) Motor and/or brush replacement
- 10) Anything else deemed necessary or helpful to the site operator

The following service checks will be performed according to the procedures described in this section. Checks may be performed more frequently, but must be performed at least at the prescribed intervals. Major maintenance activities (i.e., sampler brush change, motor replacement, housing changes, etc.) will require a single point calibration check upon completion.

A.6.1 QUARTERLY/SEMI-ANNUAL CHECKS

All maintenance checks must be recorded in the site logbook. A single point flow rate verification must be done quarterly. This can be done by the operator or an auditor, or any combination thereof, as long as one check is done each calendar quarter.

Under normal operating conditions, the SSI should be completely disassembled and cleaned, and the impaction shim re-coated after 60 full 24-hour sampling periods, or every six months, whichever is sooner. It is highly recommended that samplers located at sites experiencing abnormally high concentrations of particulates be cleaned after 30 sampling periods (or every three months) to prevent particle bounce-off. Follow the steps listed below:

- 1) Make sure the tubing is properly connected to both the flow recorder and the motor housing pressure tap. Also, inspect tubing for creases, cracks, and loose connections.
- 2) Inspect the large threaded locking collar located between the filter holder and the top of the volumetric flow controller for looseness, and tighten if necessary.
- 3) Separate the SSI in the middle and open it to inspect the cleanliness and position of the silicon coated impaction plate. If dirty, clean the plate with soapy water, dry thoroughly, apply an even application of silicon to the impaction plate, and reinstall with silicon greased side up. Clean as often as necessary to prevent particle "bounce off."
- 4) Inspect the motor brushes. Allowing the brushes to wear down completely causes electrical arcing, which will permanently damage the commutator. It is recommended that the brushes be changed every 336 hours (14 consecutive 24-hour runs) of operation. It may be necessary to change less or more frequently, depending upon ambient particulate concentrations and motor condition. Seat the motor brushes according to the manufacturer's instructions.
- 5) During the brush inspection, inspect the commutator. Once the commutator becomes worn, the brush life is reduced significantly. Replace the motor if the commutator shows excessive wear (more than 0.125 inch total), deep grooving, or lack of segmentation.
- 6) Inspect the motor when replacing the brushes. Pull at the center motor shaft to check for excessive in-play. If shaft in-play exceeds 0.0625 inches (1/16 inch) in any one direction, replace the motor.
- 7) Inspect the motor wiring for abnormalities (e.g., burned, or scorched wires).
- 8) Inspect the top and bottom rubber motor gaskets for wear or deterioration. Replace the gaskets if necessary. Twisted power leads may indicate that motor gaskets are not holding the motor firmly. This also indicates that the gaskets may need to be replaced.
- 9) Inspect the gasket between the filter holder and the critical orifice volumetric flow controller, and replace if necessary.

- 10) Inspect the gasket between the filter holder and the sampler head base plate, and replace if necessary.
- 11) Check the motor housing for cracks, and replace if necessary.
- 12) Check the power cord to the motor housing and replace if deteriorated.

A.6.2 ANNUAL CHECKS

Inspect the elapsed time indicator when installing the sampler for proper operation. Compare this elapsed time indicator annually against a standard timepiece, of known accuracy, recently set to the appropriate time zone. Official time should be synchronized with the NIST and United States Naval Observatory clock, found at www.time.gov. If they do not agree within ± 2 minutes per 24 hours, replace the unit.

A.6.3 SPARE PARTS

Part of preventative maintenance is keeping an on-hand spare parts supply. The following is a suggested list for PM₁₀ sampler supplies. The number and amount of supplies will vary depending on the size of the network.

- Motor housing and end plates
- Flow chart recorders
- Timers
- Elapsed time meters
- Filter cassettes
- Motors
- Brushes
- Thick motor gaskets
- Motor end plate gaskets
- Filter holder gaskets
- Flow chart paper
- Pigtail (motor housing)
- SSI gaskets (set)
- Silicon spray
- Pens
- Barometers
- Thermometers
- 36-inch manometers

A.7 TROUBLESHOOTING

When the monitor becomes inoperable for an unknown reason, the site operator may have to troubleshoot to determine the cause of the failure. Below is a partial list of solutions for two of the most common problems encountered when operating PM₁₀ samplers.

Symptom: Unit does not power up.

Check:

- 1) Power cords. Are they plugged in?
- 2) Brushes (disassemble motor)
- 3) Breaker and/or fuses on power supply.
- 4) Wires. Are all wires from the motor connected properly?
- 5) Timer. Is it wired properly? Worn? Check by bypassing timer.

Symptom: Unit functions, but flow trace is uneven, or flow trace is higher/lower than previous runs.

Check:

- 1) Tubing between the motor and flow recorder; Look for cracks, leaks, etc. and look to see if pinched or cracked.
- 2) Motor housing; Look for cracks, leaks, etc.
- 3) Flow recorder pen; Is it secured in place or loose?
- 4) Filter; Has it been exposed to weather and become wet, or otherwise inadvertently soiled? Have two been loaded?
- 5) Sample train; Are there restrictions in it?
- 6) VFC throat adapter connection.

NOTE: Daily line voltage fluctuations can cause an uneven trace. If the monitor is located on a building and sharing power with heating or air conditioning units, equipment cycling will cause fluctuations in the line voltage.

A.8 SPECIAL PROJECT MONITORING

Special project monitoring will be conducted under the guidance in this document or otherwise as reviewed and approved on a case-by-case basis. Special projects may require more stringent procedures depending upon the purpose of the data and the scope of the project. Specific written procedures or methodologies for the operation of PM₁₀ monitors or for data handling must be adhered to by all those individuals, firms, or agencies that are producing air quality data for enforcement purposes or under the terms of an air quality permit.